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TITLE OF INVENTION

COAGULANT COMPOSITION CONSISTING OF ORGANIC COAGULANT OF BROWN ALGAE AND INORGANIC COAGULANT

Technical Field

The present invention relates to a coagulant composition comprising brown algae and inorganic coagulant. More specifically, the present invention relates to a inorganic/ organic coagulant composition comprising one or more calcium component selected from the group consisting of the powder of shells, gypsum, and calcium carbonate, and aluminum sulfate as an aluminum ion as the inorganic component; and brown algae containing arginine as a organic component.

The coagulation means generally sedimentation treatment in case of separation and removal of the impurities which cause turbid water or color of water, but when the particles in the turbid water are too small to be sedimented, it means enlarging the particles in the turbid water to the large size particle and then sedimenting them. The organic or inorganic material of the fine particles, or the colloidal material or solved material is treated by sedimentation or adsorption in the chemical coagulation method. Such a chemical coagulation method is generally used in combination with the biological treatment. And coagulation removes impurity causing turbidity such as clay, virus, algae, color matter, colloid, organic matter, etc. And also since coagulation removes taste and odor, it is used for the polluted surface water or various wastewaters. Coagulation treatment is generally used for pre-treatment of sedimentation or filtration. When the wastewater is filtered to re-use, it is required to make the amount of the solid matter in the filtered water be of little quantity by coagulating and filtering effectively for

lessening a load. Therefore, a combination of coagulation with sedimentation is broadly used in the treatment of the wastewater, since it removes effectively the colloidal particles, the chromaticity, and BOD, and sediments the impurity rapidly.

The principle of coagulation is to change the electrical property of the colloid, and reducing the ratio of surface area to the weight thereof, thereby causing sedimentation easily. That is to say, the minute particles including the colloidal particles floating in the water show the electrical charges of positive (+) or negative (-) charge, and the same charge makes repulsion each other. When some material having the opposite charge against the charge is added, the impurities being floated in the water forms floc by the power of van der Waals between both particles.

Background Art

Such a treatment process using coagulation and sedimentation is used generally as a physico-chemical unit process over the wastewater process, which is known as a removing method of the polluted material by the four kinds of mechanism of the double layer pressing, adsorption and neutralization of the electrical charge, and cross-linkage of particles.

The coagulant is classified to the organic and inorganic one. The inorganic coagulant includes aluminum salts such as aluminum sulfate, aluminum oxide, etc., iron salts such as ferrous sulfate, ferric sulfate, ferric chloride, etc., magnesium salts such as magnesium oxide, magnesium carbonate, etc. The inorganic polymeric coagulant includes polyaluminum chloride, polyaluminum sulfate, polyferric chloride, polyferric sulfate, etc. Since such an inorganic polymeric coagulant is involved in neutralization of the charges, it cannot form the large floc, and the resulted floc is easily floated due to its lightweight. And because the pH of coagulation is very narrow, it is corrosive to the metal. Furthermore it is expensive.

When the aluminum type coagulant is used, there is a possibility that the amount of aluminum over the criteria after treatment of coagulation remains, of which the remained aluminum may be cause to Alzheimer's disease, and so many countries restrict to the content of aluminum up to 0.2 mg/L. And therefore other coagulants than the aluminum type coagulant are recommended to use in some countries such as England or Australia.

In the meanwhile, the organic polymeric coagulant acts the neutralization and also forms the large floc by cross-linkage between the particles, and the change of pH is not found after treatment. Moreover it is not found the precipitate of the coagulant, there occurs less the sludge than the inorganic coagulant, and the toxicity is very low. And therefore, it is broadly used to the polluted water, when the inorganic coagulant cannot be used. Such a polymeric organic coagulant is classified to non-ionic, cationic, and anionic ones, and the polymeric organic coagulant is selected from the point of ionic state, the degree of dissolved matter, the pH range etc. However, such a polymeric organic coagulant is too expensive, and it takes much time to activate.

Accordingly, the development of improved coagulant solving the above defects has been desired.

The present inventors have undertaken earnest studies in order to solve the above problems in the prior art, and as a result have found that the coagulant comprising aluminum type coagulant as less as possible, the powder of shell, gypsum and or calcium carbonate as a main inorganic component and the brown algae as an organic coagulant, can be replaced with the conventional polymeric organic coagulant, such a coagulant has an excellent coagulating effect, also the sedimented sludge amount is very smaller than the conventional coagulant and is sponge-like, and so it is easy to treat sludge without second treatment. Such a finding leads to the completion of the invention.

Disclosure of Invention

Accordingly, the object of the present invention is to provide a coagulant composition .comprises essentially the brown algae, which does not occur secondary pollution, cheap, and shows the effective coagulation.

Another object of the present is to provide a coagulant composition comprises inorganic component consisting of calcium ion component and aluminum ion component; and brown algae as an organic component.

Brief Description of Drawings

FIG. 1 is a diagram showing formation of the large floc from the minute particles in the wastewater.

FIG. 2 is a photograph showing treatment process of wastewater discharged from a cowshed.

Best Mode for Carrying Out the Invention

The present invention is provide a coagulant composition comprising the inorganic components consisting of not more than 5 % by weight of the aluminum compound and more than 90% by weight of the calcium compound; and 5 to 30% by weight of the brown algae as an organic component to the inorganic components.

An additive such as the active carbon, zeolite, quartz porphyry, etc. may be incorporated to the present coagulant composition, depending upon the kinds of the wastewater. When such a component is incorporated to the present composition, it is prefer to use it as a powder of up to 200 mesh, and also it is desirable to add it 1 to 10 part by weight to the total composition, which may be incorporated according to the conventional methods.

There are various kinds of the coagulant for treatment of the wastewater, and most of them consist of single substance of an inorganic or organic compound. And therefore it is difficult to effectively coagulate and sediment the impurities and it requires frequently the auxiliary coagulant, which causes the economical burden. In order to solve such a problem, the present inventors incorporate the inorganic component to the organic component, which coagulates, sediments and separates the inorganic or organic impurities being existed in the wastewater, to lead the effective purification of the wastewater.

Hereafter, the mechanism of the coagulant composition of the organic component combined with the inorganic component according to the present invention is explained as follows.

When using the coagulant composition of the inorganic component combined with the organic component according to the present invention, the expected mechanism according to process of the coagulation reaction is considered to the following two courses:

First step: an excess of $CaSO_4$ or $CaCO_3$ + $Al_2(SO_4)_3$ + impurities of the positive (+) or negative (-) charge → (Adsoption) → [Al^{3+} - the small volumetric material having the negative

charge] + [Ca^{2-} - the large volumetric material having the negative charge] + [SO_4^{2-} - material having positive charge] + [CO_3^{2-} - material having positive charge]: (A) course: the minute floc formation.

Second step: (A) + organic type coagulant → (mutual crosslinkage)→ (B) course: the larger floc formation → rapid sedimentation.

As described in the above, in the first step, calcium sulfate, or calcium carbonate and aluminum sulfate in the inorganic coagulant, which is added to the wastewater, is/are dissociated to generate the calcium ion (Ca^{-2}), aluminum ion (Al^{+3}), and carbonate ion (CO_3^{2-}) or sulfate ion (SO_4^{2-}). Here, upon the concept of the small volumetric particles/the large volumetric particles/acid/base order, the large calcium ions adsorb the impurities having the large negative charges, and the small aluminum ions adsorb the impurities having the small negative charges; and the sulfate ions adsorb the metal type impurities having the positive charges by interaction, respectively. The organic coagulant mixed in the treatment of the wastewater in the first step is solved to show the viscous property, and the viscous organic coagulant forms the large and heavy floc by strongly crosslinking the separated small flocs, which results the rapid sedimentation

The above mechanism is shown in the Fig. 1.

The components used in the present invention is explained in detail hereinafter.

The organic coagulant used in the present invention includes the brown algae. As the brown algae, sea tangle, brown seaweed, agar-agar, etc. and such material is a basic food and also acts the purification of the polluted sea. Such a sea algae has been studied continueously, but it has never been used for the coagulant component or the composition containing it. As a result of studying the algae and analogs thereof, the red algae and green algae do not have any effect to coagulate the impurities substantially, although they are known as having an effect of

an adsorption of metal ion, as shown in the following table 1.

Table 1. (Experimental result of the wastewater on green algae and red algae)

(unit: ppm)

Wastewater	COD	SS	TN*	TP*	Zn	Pb	Cd	Mn	Fe	Cr	Cu
Wastewater From cowshed	843	260.7	324.6	43.9	0.4	0.03	0	0.56	2.10	0.05	0.07
Green algae (AT*)	160.2	108	61.56	12.5	0.09	0.01	0	0.28	0.89	0.01	0.01
Red algae (AT*)	156.8	68.0	59.6	10.7	0.10	0.01	0	0.21	0.42	0.01	0.02
Red algae soln (AT*)	151.7	47.0	50.7	7.9	0.08	0.01	0	0.12	0.38	0.01	0.01
Exudated water	713	232.1	439.1	9.42	1.12	0	0	2.75	2.92	0.06	0.02
Green algae (AT*)	135.5	78.8	67.5	1.22	0.11	0	0	0.27	0.26	0.01	0.01
Red algae (AT*)	108.0	49.2	52.4	0.97	0.11	0	0	0.26	0.27	0.01	0.01
Red algae soln (AT*)	64.2	22.8	39.5	0.85	0.08	0	0	0.25	0.25	0.01	0
Wastewater From butchery	7130	1324	1080.3	163.24	2.37	0.04	0	1.44	49.92	0.02	1.57
Green Algae(AT*)	170.5	67.5	78.5	10.5	0.08	0.01	0	0.44	1.33	0.01	0.03
Red algae (AT*)	146.2	53.0	37.0	7.8	0.07	0.01	0	0.03	1.22	0.01	0.02
Red algae soln (AT*)	129.0	24.8	19.4	3.1	0.05	0.01	0	0.01	0.98	0.01	0.01
Wastewater from plating	597	128	2.2	0.52	9.23	5.25	0.14	0.02	1.93	0.16	1653
Green Algae(AT*)	268.5	57.6	0.99	0.37	3.22	0.99	0.11	0.01	0.40	0.08	1232
Red algae (AT*)	254.0	54.5	0.95	0.24	3.25	0.01	0.09	0	0.32	0.08	1242
Red algae soln (AT*)	238.8	51.2	0.80	0.12	2.32	0.98	0.08	0	0.10	0.07	1201

note:

1) TN*: TOTAL NITROGEN CONTENTS

2) TP*: TOTAL PHOSPHORUS CONTENTS

3) AT*: AFTER TREATMENT

4) The wastewater from a cowshed is diluted to 5 times, exudated water is diluted to 10 times, the wastewater from buchery is diluted to 50 times and the wastewater from plating is diluted to 2 times, before experiment,

In the above, the sea tangle from Cheju Island in Republic of Korea was used for the brown algae, and the agar-agar from Cheju Island in Republic of Korea was used for the red algae. And the red algae solution was prepared by boiling the agar-agar to give the gel-like solution. The amount of solution was 5 mℓ to 10 g of the sample.

It is apparent from the above table 1 that the red algae or green algae did not express the effect of coagulation, and after Jar Test, the green algae showed lessening the COD value to 5 to 8 % to the wastewater except the wastewater from plating, whose COD removal rate was about 10%. So, it can be concluded that the green algae and red algae are not proper for coagulant.

The present invention is to utilize the mucilages (viscous polysaccharide), especially the characteristics of algin or alginic acid. Such mucilages exist for a long time on the earth with the protein and fat, which is a constituent of the animal and plant and plays an important role in life world. Especially, the plant mucilages are the kind of the water-soluble viscous saccharides, which exist in the higher plant as well as the sea algae and the structures thereof are various. The polysaccharides in the sea algae are roughly classified the stored saccharides and the saccharide constituting the cell wall. And the many saccharides constituting the cell wall are solved in the water, salt solution and/or alkaline solution. There are D-glucose, D-manose, D-xylose, D-ribose, D-glucuronic acid, D-galacturonic acid, etc. in the sea algae, and most of them include sulfonic acid ester. Especially, in the brown algae, alginic acid constitutes the cell wall and also fills between the cell walls. The constituting components of the said alginic acid are D-manuronic acid and D-glucoronic acid, and the former is linked to beta- and the latter is linked to

alpha-1, 4-glucoside. Such components are known as the mixture of the inhomogeneous polyglucuronic acids, which are stable to the acid hydrolysis and especially sodium alginate forms the strong viscous aqueous solution. Besides, the viscous fucoidan in the brown algae as a filler exists as the form of L-fucose-4-sulfate, which has the 1,2-linkage structure, L-fucose-4-sulfate molecule is linked to the 3-position of a part of the constituting saccharides, and also D-xylose, D-glucuronic acid, etc. are included, and therefore the structure is complicated. Such sea algae due to the structural various properties on the mucilages are broadly used in the field of the carrier of electrophoresis, cosmetics, food, etc.

In the present invention, the above brown algae such as the sea tangle, brown seaweed, agar-agar, etc. is used in the form of the powder or extract thereof. When it is used in the form of the powder, the size thereof is not restricted, but it may be about 100 to 300 mesh, preferably about 200 mesh or more in the aspect of the surface area to be coagulated. Extract as above means what extracts the brown algae by water or lower alcohol such as methanol, ethanol, etc. at the temperature of the room temperature to 100℃. The organic component of the brown algae may be incorporated preferably to about 1 to 30 % by weight to the total composition.

The inorganic components include the calcium ion-generating component and aluminum ion-generating components. The calcium ion generating component may include the powdered sea shell such as an oyster, a mussel, a large clam, a clam, etc., which is prepared by washing it to remove salt component and then grinding it. However, it is very difficult to collect it and to remove the salt component, and therefore it may be replaced with gypsum or calcium carbonate. As a result of the experiment, it is most prefer to incorporate the gypsum to the powdered seashell at a ratio of 8:2 to 5:5. Furthermore, it is prefer to use the particle size of 100 to 300 mesh of the calcium compound. When using the calcium sulfate for a reagent instead of gypsum, it does not occur a coagulation and sedimentation. The present inventors think that it is may be

because calcium sulfate for a reagent is different from gypsum in the difference of the pores or molecular structure. It is possible to use calcium carbonate instead of the powdered shells, but calcium carbonate having the fine pores is desirable. It is possible to use one selected from the group consisting of the powdered gypsum, the powdered shells and calcium carbonate, but as to the wastewater containing a lot of the heavy metals, the gypsum powder is prefer to calcium carbonate.

Aluminum compounds include aluminum sulfate, alum, etc. Among them, the cheap aluminum sulfate shows the sufficient effect and it is prefer to use the powdered form before incorporation.

As to the foul smelling wastewater, the other additives such as active carbon, zeolite, quartz porphyry, etc., which is treated at 500℃ or less and pulverized to 200 meshes or below, may be added.

EXAMPLES

Now, the present invention will be described more specifically below based on working examples. It should be noted, however, that the present invention is not limited in any respect by these working examples.

Example 1

The oysters, the mussels, the large clams and the clamshells were collected at Tong-yong seaside, Republic of Korea, washed with water 5 times for 24 hours, dried, pulverized with Jaw crusher and ball mill, and screened to obtain the powder of 200 mesh or more. 5 parts by weight of aluminum sulfate were added to 100 parts by weight of the calcium component raw material obtained from above to prepare the inorganic coagulant (A).

And a sea tangle was dried and then pulverized to 200 meshes, which was used as the

organic coagulant (B).

The 100 parts by weight of the above inorganic coagulant (A) were incorporated to the 10 parts by weight of the above organic coagulant (B) to give a "coagulant composition 1".

Example 2

The "coagulant composition 2" was prepared by incorporating the 100 parts by weight of the above inorganic coagulant (A) to the 5 parts by weight of the above organic coagulant (B), as similar to the Example 1.

Example 3

The "coagulant composition 3" was prepared by using the mixture of the powdered shells of the Example 1 and the powdered gypsum at a ratio of 2 to 8, instead of the inorganic coagulant (A), in the Example 1.

. Example 4

The "coagulant composition 4" was prepared by replacing the inorganic coagulant (A) in the Example 1 with the mixture of the powdered gypsum and calcium carbonate powder at a ratio of 5 to 5 in the Example 1.

Example 5

The fossilized shells were collected at Cheju island, Republic of Korea, washed with water 5 times for 24 hours, dried, pulverized with Jaw crusher and ball mill, and screened to obtain the powder up to 200 mesh. To this powder, the gypsum powder is added in an amount of 4 times to prepare the inorganic coagulant (A).

And a sea tangle was dried and then pulverized to 200 meshes, which was used as the organic coagulant (B).

The 100 parts by weight of the above inorganic coagulant (A) were incorporated to the 30 parts by weight of the above organic coagulant (B) to give a "coagulant composition 5".

Test Example

1) Test Method

The various wastewaters are experimented by Jar Test (Coagulation Test).

In order to suppress the change of state of the wastewater, the wastewater was maintained at 4℃ for testing the coagulation. Six beakers of 1000 ml were operated simultaneously using the conventional Jar Test Apparatus. The samples of wastewater in each beaker are agitated at a high speed (100 rpm) for one minute, were stood for three minutes, and then the supernatants were analyzed for COD_{Mn}, SS (Suspended Solid), the turbidity, etc. In the conventional test method, the sample is agitated at a high speed of 100 rpm for 3 to 5 minutes, at a low speed of 40 to 50 rpm for 10 to 15 minutes, and was stood for about 1 hour, and then the turbidity, color, pH, etc. thereof were measured. But, when to use the present coagulant, the coagulation and sedimentation occur immediately after addition of the present coagulant. And therefore, agitation step in the present coagulation was finished in one minute. But because the conventional coagulants in the Comparative Examples do not occur the coagulation and sedimentation as the coagulation of the present invention, the test was carried out, being similar to the conventional method, i.e. 100 rpm for the first one minute, 50 rpm for one minute, and stood for 5 minute, and then various test was carried out for the conventional coagulant in the Comparative Examples.

The coagulant effect of the coagulants to the wastewater was adjusted to the each condition, and then the Jar Test was carried out 3 times. The mean values thereof of the test were shown in the tables.

Test Example 1 (Coagulation effect to the wastewater from the cowshed)

The wastewater from the cowshed in the Whasung, Kyoungki-do, Republic of Korea was primarily filtered, and tested by Jar Test method, using the coagulant composition 1 of the

Example 1. The results thereof are shown in the Table 2

In the Table 2, the wastewater was diluted to 5 times, and the "0" in the coagulant amount means the results to the non-diluted wastewater.

As appeared in the Table 2, the coagulation effect was the highest, when the amount of the coagulant was used in an amount of 3 to 5 grams and the COD reducing effect is about 87 to 90% all over the ranges. SS was not detected almost, and the total nitrogen content was drastically reduced. And the hydrogen ion concentration indices (pH) of the samples were lowered to almost neutral. The wastewater was turbid, brownish, and severe odor, before treatment. After one minute from addition of the coagulant of the present invention, the coagulation was occurred and after several minutes from stopping the agitation, the samples changed to be clean to the almost colorless solution, and there was an odor.

Table 2

Amount of the coagulant (g)	pH after treatment	COD*1 (PPM)	SS*2 (PPM)	Color	Transpa-rency*3	*3Hight of sludge (cm)	*4Weight of sludge (g)	*5 Total nitrogen content (ppm)
0	7.76	843.0	260.7	Brown	1	0	0	324.6
1	7.09	21.9	4.0	Pale yellow	4	0.6	0.80	3.0
3	6.97	17.9	2.8	Pale yellow	5	0.8	1.00	0.8
5	6.92	16.8	2.5	Pale yellow	5	1.0	1.12	0.6
7	6.83	18.7	3.4	Pale yellow	3	1.2	1.92	1.2
10	6.72	19.5	4.0	Pale yellow	2	1.5	3.51	2.6

Note: *1: measured by Mn oxidation method.

*2: The higher in value, the better.

*3: The piled-up height in the 1000 mℓ mass cylinder.

*4: measured after drying for 24 hours.

*5: measured by IR spectrometer.

Test Example 2 (Coagulation effect to the wastewater from the pigsty)

The wastewater from the pigsty in the J-city, Chungbuk, Republic of Korea was primarily filtered, and tested by Jar Test method, using the coagulant composition 2 of the Example 2. The results thereof are shown in the Table 3

In the Table 3, the wastewater was diluted to 10 times, and the "0" in the coagulant amount means the results to the non-diluted wastewater.

As appeared in the Table 3, the coagulation effect was the highest, when the amount of the coagulant was used in an amount of 5 to 7 grams and the COD reducing effect is about 82 to 87% all over the ranges. SS was not detected almost, and the total nitrogen content was drastically reduced. And the hydrogen ion concentration indices (pH) of the samples were lowered to almost neutral. The wastewater was turbid, brownish, and severe odor, before treatment. After one minute from addition of the coagulant of the present invention, the coagulation was occurred and after several minutes from stopping the agitation, the samples changed to be clean to the almost colorless solution, and there was an odor.

Table 3

Amount of the coagulant (g)	pH after treatment	COD*1 (PPM)	SS (PPM)	Color	Transparency*2	*3Hight of sludge (cm)	*4Weight of sludge (g)	*5 Total nitrogen content (ppm)
0	9.09	1472	533	brown	1	0	0	510.6
1	8.09	26.2	8.4	pale yellow	4	0.7	1.52	4.18
3	8.00	20.0	7.6	pale yellow	5	0.9	2.11	3.55
5	7.80	19.1	5.8	pale yellow	5	1.0	2.37	3.21
7	7.73	20.4	6.8	pale yellow	3	1.5	3.16	3.91
10	7.66	22.4	8.1	pale yellow	2	1.8	4.86	4.10

Note: *1 to *5 are same with those in Table 2.

Test Example 3 (Coagulation effect to the wastewater leaked from the waste disposal sites)

The wastewater leaked from the waste disposal site in Chungju-shi, Chungbuk, Republic of Korea was tested by Jar Test method, using the coagulant composition 1 of the Example 1. The results thereof are shown in the Table 4

In the Table 4, the wastewater was diluted to 10 times, and the "0" in the coagulant amount means the results to the non-diluted wastewater.

As appeared in the Table 4, the coagulation effect was the highest, when the amount of the coagulant was used in an amount of 3 to 5 grams and the COD reducing effect is about 80 to 84% all over the ranges. SS was not detected almost, and the total nitrogen content was drastically reduced. And the hydrogen ion concentration indices (pH) of the samples were lowered to almost neutral. The wastewater was turbid, dark blue, and severe odor to occur the headache and vomiting, before treatment. After one minute from addition of the coagulant of the

present invention, the coagulation was occurred and after several minutes from stopping the agitation, the samples changed to be clean perfectly, almost colorless to pale green solution, and there was an odor.

Table 4

Amount of the coagulant (g)	pH after treatment	COD*1 (PPM)	SS (PPM)	Color	Transpa-rency*2	*3Hight of sludge (cm)	*4Weight of sludge (g)	*5 Total nitrogen content (ppm)
0	7.88	713.0	232.1	dark blue	1	0.8	0.80	439.1
1	7.66	14.2	5.7	pale green	3	0.9	0.90	2.47
3	7.45	12.0	4.2	pale green	4	1.0	1.00	1.47
5	7.29	11.4	2.0	pale green	4	1.2	1.47	0.72
7	7.17	11.9	3.8	Pale green	3	1.5	2.24	0.93
10	6.99	12.8	6.8	pale green	2	1.7	3.08	2.47

Note: *1 to *5 are same with those in Table 2.

Test Example 4(Coagulation effect to the wastewater from the dye works)

The wastewater from the dye works in C-city, Chungnam, Republic of Korea was tested by Jar Test method, using the coagulant composition 5 of the Example 5. The results thereof are shown in the Table 4

As appeared in the Table 5, the coagulation effect was the highest, when the amount of the coagulant was used in an amount of 7 to 15 grams and the COD reducing effect is about 92 to 95% all over the ranges. SS was not detected almost, and the total nitrogen content was drastically reduced. And the hydrogen ion concentration indices (pH) of the samples were lowered to almost neutral. The wastewater was turbid, dark gray, and not too severe odor, before treatment. After one minute from addition of the coagulant of the present invention, the coagulation was occurred and after several minutes from stopping the agitation, the samples

changed to be clean perfectly, and colorless solution.

Table 5

Amount of the coagulant (g)	pH after treatment	COD*1 (PPM)	SS (PPM)	Color	transparency*2	*3Hight of sludge (cm)	*4Weight of sludge (g)	*5 Total nitrogen content (ppm)
0	6.87	1380	132	dark gray	1	0	0	1080.3
5	6.67	102.2	6.9	colorless	4	3.7	9.05	5.0
7	6.65	72.3	4.3	colorless	4	4.3	14.58	4.4
10	6.58	69.8	3.0	colorless	4	4.8	19.53	4.5
15	6.50	70.3	4.7	colorless	3	6.5	24.95	4.5
20	6.43	98.6	5.5	colorless	2	8.5	31.87	4.7

Note: *1 to *5 are same with those in Table 2.

Test Example 5(Coagulation effect to the wastewater from the butchery)

The wastewater from the butchery in Jaechun-shi, Chungbuk, Republic of Korea was tested by Jar Test method, using the coagulant composition 3 of the Example 3. The results thereof are shown in the Table 6

In the Table 6, the wastewater was diluted to 50 times, and the "0" in the coagulant amount means the results to the non-diluted wastewater.

As appeared in the Table 6, the coagulation effect was the highest, when the amount of the coagulant was used in an amount of 15 to 20 grams and the COD reducing effect is about 80 to 83% all over the ranges. SS was not detected almost, and the total nitrogen content was drastically reduced. And the hydrogen ion concentration indices (pH) of the samples were lowered to almost neutral. The wastewater was turbid, dark red, and severe odor to occur the headache and vomiting, before treatment. After one minute from addition of the coagulant of the present invention, the coagulation was occurred and after several minutes from stopping the agitation, the samples changed to be clean perfectly, almost colorless to pale yellow solution, and there was an odor.

Table 6

Amount of the coagulant (g)	pH after treatment	COD*1 (PPM)	SS (PPM)	Color	transparency*2	*3Hight of sludge (cm)	*4Weight of sludge (g)	*5 Total nitrogen content (ppm)
0	6.88	7130.0	1324.0	dark red	1	0	0	1080.3
10	6.26	28.5	8.4	pale yellow	4	3.7	9.05	5.0
15	5.76	24.5	5.4	pale yellow	4	4.3	14.58	4.4
17	5.50	25.7	5.6	pale yellow	4	4.8	19.53	4.5
20	5.47	26.7	6.6	pale yellow	3	6.5	24.95	4.5
25	5.47	28.5	7.9	pale yellow	2	8.5	31.87	4.7

Note: *1 to *5 are same with those in Table 2.

Test Example 6 (Coagulation effect to the wastewater from hospital)

The wastewater from the hospital in H-city, Chungbuk, Republic of Korea was tested by Jar Test method, using the coagulant composition 2 of the Example 2. The results thereof are shown in the Table 7

As appeared in the Table 7, the coagulation effect was the highest, when the amount of the coagulant was used in an amount of 3 to 7 grams and the COD reducing effect is about 83 to 88% all over the ranges. SS was not detected almost, and the total nitrogen content was drastically reduced. And the hydrogen ion concentration indices (pH) of the samples were lowered to almost neutral. The wastewater was turbid, dark gray, and severe odor, before treatment. After one minute from addition of the coagulant of the present invention, the coagulation was occurred and after several minutes from stopping the agitation, the samples changed to be clean perfectly, and colorless solution.

Table 7

Amount of the coagulant (g)	pH after treatment	COD*1 (PPM)	SS (PPM)	Color	transparency*2	*3Hight of sludge (cm)	*4Weight of sludge (g)	*5 Total nitrogen content (ppm)
0	7.27	18.4	12.0	dark gray	1	0	0	4.4
1	6.79	3.2	2.9	colorless	2	0.3	9.05	2.2
3	6.67	2.3	2.3	colorless	3	0.5	14.58	0.8
5	6.37	2.2	1.5	colorless	5	0.6	19.53	1.7
7	6.31	2.8	1.7	colorless	4	1.1	1.53	1.0
10	5.85	3.0	1.9	colorless	4	1.2	3.44	1.0

Note: *1 to *5 are same with those in Table 2.

Test Example 7 (Coagulation effect to the wastewater from the plating works)

The wastewater from the plating works in Kyongki-do, Republic of Korea was tested by Jar Test method, using the coagulant composition 4 of the Example 4. The results thereof are shown in the Table 8.

In the Table 8, the wastewater was diluted to 2 times, and the "0" in the coagulant amount means the results to the non-diluted wastewater.

As appeared in the Table 8, the coagulation effect was the highest, when the amount of the coagulant was used in an amount of 3 to 5 grams and the COD reducing effect is about 93 to 97% all over the ranges. SS was not detected almost, and the total nitrogen content was drastically reduced. And the hydrogen ion concentration indices (pH) of the samples were lowered to almost neutral. The wastewater was turbid, dark gray, and not too severe odor, before treatment. After one minute from addition of the coagulant of the present invention, the coagulation was occurred and after several minutes from stopping the agitation, the samples changed to be clean perfectly, and colorless solution.

Table 8

Amount of the coagulant (g)	Ph after treatment	COD*1 (PPM)	SS (PPM)	Color	transparency*2	*3Hight of sludge (cm)	*4Weight of sludge (g)	*5 Total nitrogen content (ppm)
0	6.9	597	128	dark gray	1	0	0	2.2
1	6.96	63.0	5.6	colorless	2	0.1	0.33	1.5
3	6.91	68.2	3.8	colorless	5	0.2	0.95	0.7
5	6.72	35.8	3.2	colorless	5	0.3	1.42	0.5
7	6.61	37.7	4.2	colorless	4	0.7	2.73	0.8
10	6.61	55.7	4.7	colorless	3	1.0	3.59	0.9

Note: *1 to *5 are same with those in Table 2.

Test Example 8 (Removal Test of Heavy Metal in the wastewater)

The original wastewater and the treated water by Jar Test using the coagulant composition of the Example 4 were measured for removal of heavy metal by ICP (Inductively Coupled Plasma Atomic Emission Spectrometry). The results thereof are shown in the Table 9.

Table 9

	P	Zn	Pb	Cd	Mn	Fe	Cr	Cu	Al
cowshed wastewater	43.91	0.40	0.03	0	0.56	2.10	0.05	0.07	1.33
treated wastewater	0.64	0.01	0.02	0	0.11	0.01	0.01	0.03	0.87
pigsty wastewater	56.66	0.85	0.34	0	0.32	3.31	0.07	0.29	1.28
treated wastewater	0.46	0.01	0.03	0	0	0.01	0.01	0.02	0.03
landfill wastewater	9.42	1.12	0	0	2.750	2.92	0.09	0.02	2.80
treated wastewater	0.14	0.02	0.04	0.01	0	0	0.01	0.02	0.36
dye wastewater	1.03	0.06	0.02	0	0.02	0.81	0.02	0.01	2.15
treated wastewater	0.95	0.03	0.02	0	0.02	0.02	0	0.02	0.03
butchery wastewater	163.24	2.37	0.04	0	1.44	49.92	0.02	1.57	2.10
treated wastewater	2.46	0.01	0.04	0.01	0	0.03	0.01	0.04	0.01
hospital wastewater	1.24	0.13	0.17	0	0.01	0.41	0	0.12	1.04
treated water	0.10	0.02	0.03	0.01	0	0	0.01	0.02	0.57
plating wastewater	0.52	9.23	5.25	0.14	0.02	1.93	0.16	1653	2.32
treated wastewater	0.4	2.32	0.10	0.08	0	0.1	0.03	1113	0.49

As shown in the above Table 9, the coagulation effect to the heavy metal in the wastewater was very excellent, and the removal rate of the total phosphorus in the cowshed and pigsty wastewater is as high as about 95% or more and the other metals were removed with a high rate. And also iron and aluminum ion are not detected in the treated wastewater. In the wastewater leaked from the trash landfill, the removal rate of the total phosphorus was very high, and the zinc and manganese were reduced at a high rate. As to the wastewater from the dye works, aluminum and iron were removed effectively, but lead and manganese were not moved effectively.

As to the butchery wastewater, the total phosphorus was removed at a high rate, and the other metals of iron, zinc, aluminum, etc. were removed at a good rate. In the case of the wastewater from the hospital, the heavy metal such as zinc, iron, aluminum, etc. were effectively

removed, and also the zinc and lead in the wastewater from the plate works were moved at a high rate. As above, almost heavy metals in every wastewater were removed at a high rate.

Example 6 (Coagulation Effect to the Cowshed Wastewater on the Mixture Rate of the Coagulant Composition)

The wastewater was treated using the coagulant of the mixture rate of calcium source, aluminum sulfate and sea tangle as shown in the Table 10, and the supernatant obtained after treatment was tested according to the method of the Test Example 1. The COD, SS, phosphorus, and nitrogen content were measured and the results thereof were described on the Table 10.

Table 10 (unit: ppm)

	pH	COD	SS	Total P	total N				
wastewater before treatment	7.76	843.0	260.7	43.91	324.6				
mixture rate Ca:AS*:ST**	pH/ treated	COD/ treated	SS/ treated	Total P/ Treated	total N/ treated	*1	*2	*3	*4
5.0:0.5:1.5	7.2	49.7	7.0	7.9	9.8	1	1	5	1
7.5:0.5:1.5	7.0	35.5	5.6	3.8	4.6.	3	3	3	3
10.0:0.5:1.5	6.9	16.8	2.5	0.64	0.6	5	5	1	5
12.5:0.5:1.5	6.9	18.0	2.7	0.8	0.8	5	5	1	5
15.0:0.5:1.5	6.8	28.6	4.3	1.0	2.7	3	3	3	3
10.0:0.25:1.5	7.2	29.8	4.9	2.5	2.9	1	1	3	1
10.0:0.50:1.5	6.9	16.8	2.5	0.64	0.6	5	5	1	5
10.0:0.75:1.5	6.8	15.4	2.7	0.6	0.52	5	5	1	5
10.0:1.00:1.5	6.7	16.4	5.4	1.0	1.0	3	3	3	5
10.0:1.25:0.5	6.7	20.5	7.2	2.2	2.42	2	3	5	2
10.0:0.5:0.5	7.2	34.7	7.8	4.8	9.7	1	1	4	1
10.0:0.5:0.75	7.1	25.6	5.2	2.72	4.22	3	3	3	2
10.0:0.5:1.00	7.0	18.2	2.8	0.72	0.72	5	5	1	5
10.0:0.5:1.50	6.9	16.8	2.5	0.64	0.6	5	5	1	5
10.0:0.5:2.00	6.9	17.2	3.4	1.24	1.22	3	3	5	3

note) AS* : Aluminum sulfate./

ST**: Sea tangle

*1: Coagulating speed,

*2: Floc size after treatment

*3: SS after treatment

*4: Transparency after treatment

*1, *2, *4: The higher, the better.

*3: The less, the better.

The calcium source is the mixture of 90 parts by weight of gypsum and 10 parts by weight of the powdered shells, the sea tangle is same with that of Example 1, and aluminum sulfate is the commercial one.

From the above Table, it is confirmed that the coagulant compositions of aluminum sulfate: calcium source: sea tangle = 0.3-0.75: 7.5-10.0: 0.75-1.5 are most desirable.

Example 7 (Coagulation Effect to the Wastewater leaked from Trash Landfill on the Mixture Rate of the Coagulant Composition)

The wastewater was treated using the coagulant of the mixture rate of calcium source, aluminum sulfate and sea tangle as shown in the Table 11, and the supernatant obtained after treatment was tested according to the method of the Test Example 1. The COD, SS, phosphorus, and nitrogen content were measured and the results thereof were described on the Table 11.

Table 11 (unit: ppm)

	pH	COD	SS	total P	total N				
Wastewater before treatment	7.88	713	232.1	9.42	439.1				
mixture rate Ca:AS*:ST**	pH/ treated	COD/ treated	SS/ treated	total P/ treated	total N/ treated	*1	*2	*3	*4
5.0:0.5:1.5	7.4	38.2	7.0	2.7	5.7	1	1	5	1
7.5:0.5:1.5	7.3	25.7	4.3	1.35	3.2	3	3	3	3
10.0:0.5:1.5	7.2	12.5	1.5	0.14	1.45	5	5	1	5
12.5:0.5:1.5	7.2	11.4	2.0	0.14	1.47	5	5	1	5
15.0:0.5:1.5	7.0	18.5	3.5	0.47	2.72	3	3	3	3
10.0:0.25:1.5	7.3	25.7	3.0	2.45	4.25	1	1	3	1
10.0:0.50:1.5	7.2	11.4	2.0	0.14	1.46	5	5	1	5
10.0:0.75:1.5	7.2	10.4	1.0	0.14	1.47	5	5	1	5
10.0:1.00:1.5	7.1	11.5	2.2	1.18	2.22	3	3	3	5
10.0:1.25:1.5	7.0	25.4	3.2	2.17	2.72	2	3	5	2
10.0:0.5:0.5	7.3	49.7	6.2	3.4	4.8	1	1	4	1
10.0:0.5:0.75	7.3	27.5	4.8	1.5	2.4	3	3	3	2
10.0:0.5:1.00	7.2	13.2	1.7	0.12	1.42	5	5	1	5
10.0:0.5:1.50	7.2	11.4	2.0	0.14	1.47	5	5	1	5
10.0:0.5:2.00	7.1	20.7	2.7	1.72	2.42	3	3	5	3

note) note) AS*, ST**, *1, *2, *3, *4: The same with those of Example 6.

The calcium source is the mixture of 50 parts by weight of gypsum and 50 parts by weight of the powdered shells, the sea tangle is same with that of Example 1, and aluminum sulfate is the commercial one.

From the above Table, it is confirmed that the coagulant compositions of aluminum sulfate: calcium source: sea tangle = 0.3-0.75: 10.0-12.5: 1.0-1.5 are most desirable.

Example 8 (Coagulation Effect to the Wastewater from Butchery on the Mixture Rate of the Coagulant Composition)

The wastewater was treated using the coagulant of the mixture rate of calcium source, aluminum sulfate and sea tangle as shown in the Table 12, and the supernatant obtained after treatment was tested according to the method of the Test Example 1. The COD, SS, phosphorus, and nitrogen content were measured and the results thereof were described on the Table 12.

Table 12 (unit ppm)

	pH	COD	SS	total P	total N				
Wastewater before treatment	6.88	7130	1324	163.24	1080.3				
Mixture rate Ca:AS*:ST**	pH/ treated	COD/ treated	SS/ treated	total P/ treated	total N/ treated	*1	*2	*3	*4
5.0:0.5:1.5	6.4	69.2	11.0	4.7	7.2	1	1	5	1
7.5:0.5:1.5	6.2	32.5	7.2	3.7	6.2	3	3	3	3
10.0:0.5:1.5	6.0	24.5	5.4	2.48	4.4	5	5	1	5
12.5:0.5:1.5	6.0	25.6	5.3	2.32	3.0	5	5	1	5
15.0:0.5:1.5	6.0	28.6	6.8	3.0	4.4	3	3	3	3
10.0:0.25:1.5	6.2	48.3	7.3	4.2	6.8	1	1	3	1
10.0:0.50:1.5	6.1	24.5	5.4	2.46	4.4	5	5	1	5
10.0:0.75:1.5	6.0	21.5	4.7	2.32	4.4	5	5	1	5
10.0:1.00:1.5	6.0	26.5	5.3	3.2	3.2	3	3	3	5
10.0:1.25:1.5	5.9	27.5	5.6	3.7	3.9	2	3	5	2
10.0:0.5:0.5	6.4	72.5	8.2	10.5	9.9	1	1	5	1
10.0:0.5:0.75	6.2	48.5	6.8	8.1	7.8	2	2	3	2
10.0:0.5:1.00	6.1	32.1	6.0	4.2	5.2	3	3	3	3
10.0:0.5:1.50	6.0	24.5	5.4	2.46	4.4	5	5	1	5
10.0:0.5:2.00	6.0	23.5	4.2	2.47	4.1	5	5	1	5

note) AS*, ST**, *1, *2, *3, *4: The same with those of Example 6.

The calcium source is the mixture of 50 parts by weight of gypsum and 50 parts by weight of the powdered shells, the sea tangle is same with that of Example 1, and aluminum sulfate is the commercial one.

From the above Table, it is confirmed that the coagulant compositions of aluminum sulfate: calcium source: sea tangle = 0.5-0.75: 10.0-15.0: 1.5-2.0 are most desirable.

Example 9 (Coagulation Effect to the Wastewater leaked from Trash Landfill on the Mixture Rate of the Coagulant Composition)

The wastewater was treated using the coagulant of the mixture rate of calcium source, aluminum sulfate and sea tangle as shown in the Table 13, and the supernatant obtained after treatment was tested according to the method of the Test Example 1. The COD, SS, and heavy metals were measured and the results thereof were described on the Table 13.

Table 13 (unit: ppm)

	pH	COD	SS	Zn	Pb	Cd	Cr	Cu	Fe
wastewater before treatment	6.90	5.97	128	9.23	5.25				
mixture rate Ca:AS*:ST**	pH/ treated	COD/ Treated	SS/ treated	Zn/ treated	Pb/ treated	Cd/ treated	Cr/ treated	Cu/ treated	Fe/ treated
5.0:0.5:1.5	6.8	64.4	7.4	3.7	1.25	0.12	0.08	1236	1.25
7.5:0.5:1.5	6.8	42.7	5.2	2.32	0.12	0.01	0.05	1170	0.17
10.0:0.5:1.5	6.7	35.8	3.2	2.3	0.10	0	0.03	1113	0.10
12.5:0.5:1.5	6.7	30.2	3.0	2.0	0.08	0	0.01	680	0.01
15.0:0.5:1.5	6.6	31.2	4.1	2.1	0.09	0	0.01	520	0.01
10.0:0.25:1.5	6.8	42.7	3.42	2.52	1.37	0.02	0.09	1212	0.18
10.0:0.50:1.5	6.7	35.8	3.2	2.32	0.10	0	0.03	1113	0.01
10.0:0.75:1.5	6.7	32.2	2.9	2.00	0.07	0	0.01	825	0.06
10.0:1.00:1.5	6.6	33.5	2.8	1.98	0.07	0	0.01	540	0.06
10.0:1.25:1.5	6.6	36.5	3.2	2.12	0.08	0	0.01	430	0.07
10.0:0.5:0.5	6.8	60.5	4.6	2.72	0.72	0.15	0.08	1320	1.00
10.0:0.5:0.75	6.8	48.2	2.8	2.41	0.32	0	0.06	1210	0.09
10.0:0.5:1.00	6.7	34.2	2.8	2.30	0.11	0	0.03	1120	0.08
10.0:0.5:1.50	6.7	35.8	3.2	1.30	0.10	0	0.03	1113	0.08
10.0:0.5:2.00	6.7	36.2	3.4	1.08	0.08	0	0.02	620	0.08

note) AS*, ST**, *1, *2, *3, *4: The same with those of Example 6.

The calcium source is the mixture of 9 parts by weight of gypsum and 10 parts by weight of the powdered shells, the sea tangle is same with that of Example 1, and aluminum sulfate is the commercial one.

From the above Table, it is confirmed that the coagulant compositions of aluminum sulfate: calcium source: sea tangle = 0.3-0.5: 7.5-10.0: 0.75-1.5 are most desirable.

Example 10 (Coagulation Effect of the Sea Tangle as Organic component to the

various Wastewater)

The wastewater was treated using the coagulant of the mixture rate of calcium source, aluminum sulfate and sea tangle as shown in the Table 14, and the supernatant obtained after treatment was tested according to the method of the Test Example 1. The COD, SS, phosphorus, and nitrogen content were measured and the results thereof were described on the Table 14.

Table 14 (unit: ppm)

Wastewater from Cowshed	pH	COD	SS	total P	Total N				
Wastewater before treatment	7.76	843.0	260.7	43.91	324.6				
Mixture rate Ca:AS*:ST soln**	pH/ treated	COD/ treated	SS/ treated	total P/ treated	total N/ treated	*1	*2	*3	*4
10.0g: 0.5g: 3 mℓ	7.2	13.2	1.0	0.72	0.6	5	3	2	4
10.0g: 0.5g: 5 mℓ	7.1	12.5	3.5	0.6	0.6	5	5	1	5
10.0g: 0.5g: 7 mℓ	7.0	14.0	2.8	1.72	1.72	3	5	2	4
10.0g: 0.5g: 10 mℓ	6.9	21.6	3.5	2.64	2.60	3	3	4	2
10.0g: 0.5g: 15 mℓ	6.9	30.5	6.4	3.24	3.22	3	1	4	2
Wastewater leaked from landfill	PH	COD	SS	Total P	Total N				
Wastewater before treatment	7.88	713	232.1	9.42	439.1				
Mixture rate Ca:AS*:ST soln**	pH/ treated	COD/ treated	SS/ treated	Total P/ treated	Total N/ treated	*1	*2	*3	*4
10.0g: 0.5g: 3 mℓ	7.3	34.7	4.8	2.5	3.4	3	1	3	1
10.0g: 0.5g: 5 mℓ	7.2	10.2	1.7	0.12	0.42	5	5	1	5
10.0g: 0.5g: 7 mℓ	7.2	9.4	0.7	0.14	0.47	5	5	1	5
10.0g: 0.5g: 10 mℓ	7.1	16.7	2.7	1.72	1.42	3	3	3	3
10.0g: 0.5g: 15 mℓ	6.9	22.5	3.8	2.24	2.22	3	3	4	3
wastewater from butchery	PH	COD	SS	Total P	Total N				
wastewater before treatment	6.88	7130	1324	163.24	1080.3				
mixture rate Ca:AS*:ST soln**	PH/ treated	COD/ treated	SS/ treated	total P/ treated	Total N/ treated	*1	*2	*3	*4
10.0g: 0.5g: 3 mℓ	6.4	68.5	7.2	9.5	8.9	1	2	4	2
10.0g: 0.5g: 5 mℓ	6.2	40.5	5.8	7.1	6.8	3	2	1	2
10.0g: 0.5g: 7 mℓ	6.1	28.1	5.0	3.2	4.2	5	2	1	5
10.0g: 0.5g: 10 mℓ	6.0	20.3	3.4	1.46	3.4	5	5	1	5
10.0g: 0.5g: 15 mℓ	6.0	21.5	4.2	1.47	3.1	3	5	4	5

wastewater from plating works	PH	COD	SS	Zn	Pb	Cd	Cr	Cu	Fe
wastewater before treatment	6.90	597	128	9.23	5.25	0.14	0.16	1663	1.93
mixture rate Ca:AS*:ST soln**	PH/ treated	COD/ treated	SS/ treated	total P/ treated	total N/ treated	*1	*2	*3	*4
10.0g: 0.5g: 3 mℓ	6.8	54.5	3.6	1.72	0.62	0.05	0.06	1110	0.09
10.0g: 0.5g: 5 mℓ	6.8	30.2	1.8	1.41	0.12	0	0.03	980	0.07
10.0g: 0.5g: 7 mℓ	6.7	31.2	2.2	0.30	0.11	0	0.01	620	0.06
10.0g: 0.5g: 10 mℓ	6.7	33.8	2.2	1.00	0.10	0	0.01	645	0.07
10.0g: 0.5g: 15 mℓ	6.7	36.2	2.4	1.08	0.11	0	0.02	660	0.07

note) AS*, *1, *2, *3, *4: The same with those of Example 6.

ST**: The sea tangle solution, which was prepared by dipping of the sea tangle (100 g) to the distilled water (2 liters), and extracting it.

The calcium source for the wastewater (dilution: 5 times) from a cowshed is the mixture of 90 parts by weight of gypsum and 10 parts by weight of the powdered shells; the calcium source for the wastewater (dilution: 10 times) from the trash landfill is the mixture of 50 parts by weight of gypsum and 50 parts by weight of the powdered shells; the calcium source for the wastewater (dilution: 50 times) from a butchery is the mixture of 50 parts by weight of gypsum and 50 parts by weight of the powdered shells; and the calcium source for the wastewater (dilution: 2 times) from a plating works is the mixture of 90 parts by weight of gypsum and 10 parts by weight of the powdered shells.

From the above Table, it is confirmed that when the sea tangle is used for an organic coagulant, coagulation is effectively attained at an amount of 3 to 5 mℓ to the cowshed wastewater, 5 to 7 mℓ to the wastewater leaked form the trash landfill, 7 to 10 mℓ to the butchery wastewater, and 5 to 7 mℓ to the wastewater from the plating works, respectively. And also the COD values and SS values were about 90%, which is reduced to about 2 to 4%,

comparing to the sea tangle powder. Besides, the coagulation ability, transparency, and removal ability of the heavy metals of the sea tangle extract are superior to those of the powdery sea tangle. But, it is inconvenient to prepare and convey the extract, and cost for preparation and operation, etc.

Comparative Example 1

Alum and polyaluminum chloride of The conventional coagulant, and the coagulant of the present Example 3 were used in an amount of 3 g respectively, to the wastewater from the cowshed, wherein the polyaluminum chloride was dissolved before 24 hours prior to use. The results thereof are shown in the following Table 15.

Table 15

	COD	SS	total P	total N				
wastewater before treatment	843	260.7	43.91	324.6				
Kind of coagulant (added amount: g)	COD/ treated	SS/ treated	total P/ treated	total N/ treated	*1	*2	*3	*4
alum (5 g)	67.4	30.42	6.1	40.44	1	1	exist	1
PAC (5 g)	49.5	27.28	4.3	31.42	2	2	a little	2
coagulant of the invention (5 g)	16.5	2.4	0.64	0.6	3	3	none	3

(unit in COD, SS, total phosphorus, and total nitrogen: ppm.

note) *1: Coagulation/sedimentation speed

*2: Floc size under treatment

*3: Transparency after treatment

*1, *2, *3: The higher in value, the better.

As appeared in the above table, alum as coagulant showed the removal rate of 60% to COD, and about 30% to SS, phosphorus, and nitrogen; polyaluminum chloride(PAC) showed the

removal rate of about 70% to COD, and about 40% to SS, phosphorus, and nitrogen; but, the coagulant of the invention showed 90% or more to each tests.

Comparative Example 2

Alum and polyaluminum chloride of the conventional coagulant, and the coagulant of the present Example 2 were used in an amount of 5 g respectively, to the wastewater leaked from the trash landfill.

The results thereof are shown in the following Table 16.

Table 16

	COD	SS	total P	total N				
wastewater before treatment	713	232.1	9.42	429.1				
kind of coagulant (added amount: g)	COD/ treated	SS/ treated	total P/ treated	total N/ treated	*1	*2	*3	*4
alum (5 g)	28.5	13.6	0.56	25.7	1	1	exist	1
PAC (5 g)	21.4	7.8	0.37	15.16	2	2	a little	2
coagulant of the invention (5 g)	11.4	2.0	0.14	1.46	3	3	none	3

(unit in COD, SS, total phosphorus, and total nitrogen: ppm.

note) *1: Coagulation/sedimentation speed

*2: Floc size under treatment

*3: Transparency after treatment

*1, *2, *3: The higher in value, the better.

As appeared in the above table, alum as coagulant showed the removal rate of 60% to COD, and about 40% to SS, phosphorus, and nitrogen; polyaluminum chloride(PAC) showed the removal rate of about 70% to COD, and about 60% to SS, phosphorus, and nitrogen; but, the coagulant of the invention showed 90% or more to each tests.

Comparative Example 3

Alum and polyaluminum chloride of the conventional coagulant, and the coagulant of the present Example 4 were used in an amount of 5 g respectively, to the wastewater from the plating works.

The results thereof are shown in the following Table 17.

Table 17 (unit: ppm)

	COD	SS	Zn	Pb	Cd	Cr	Fe
wastewater before treatment	597	128	9.23	5.25	0.14	0.16	1.93
kind of coagulant (added amount: g)	COD/ treated	SS/ treated	Zn/ treated	Pb / treated	Cd/ treated	Cd/ treated	Cd/ treated
alum (5 g)	119.4	24.6	3.70	2.15	0.10	0.10	1.08
PAC (5 g)	89.6	18.2	2.82	1.27	0.08	0.08	1.02
coagulant of the invention (5 g)	35.8	3.20	2.12	0.10	0	0.01	0.10

As appeared in the above table, alum as coagulant showed the removal rate of 60% to COD, and about 60% to SS, phosphorus, and nitrogen; polyaluminum chloride(PAC) showed the removal rate of about 70% to COD, and about 70% to SS, phosphorus, and nitrogen; but, the coagulant of the invention showed 90% or more to each tests.

INDUSTRIAL UTILIZABILITY

As described in the above, when treating the various kind of the wastewater with the coagulant of the present invention, coagulating ability is very strong, and sedimentation is very fast, and therefore the applicability is very broad to be applied to the various kind of the wastewater. And also the floc size is very large and soft like sponge, thereby being easy to effect the secondary sludge treatment. Especially, the turbidity of the origin wastewater can be

easily removed immediately after adding the coagulant of the invention, to give the transparence solution. And the aluminum contents among the treated wastewater are very low, and therefore, it is possible to solve the problems due to aluminum compounds or aluminum ion. And also the treated wastewater is almost neutral, and so it is not necessary to neutralize it by acid or base.